Deschutes National Forest

Western Spruce Budworm: An Epidemic Control Feasibility Analysis Using the FORPLAN Model

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MANAGEMENT SUMMARY: The potential impact of a western spruce budworm epidemic on the Deschutes National Forest was modeled using FORPLAN. The present net value (PNV) of the timber resource, allowable harvest quantity, and the long run sustained yield were compared using the strategies of no treatment and treatment with insecticide in the third year of the outbreak. In a worst-case epidemic scenerio, insecticide treatment increased the PNV by less than one percent. The long run sustained yield and allowable harvest quantity were also increased by less than one percent. The impact of a budworm epidemic on other resource values is predicted to be minimal. Based in part on this analysis, management should decide whether to proceed with an environmental assessment to evaluate alternatives for control of the budworm outbreak. Alternatives could include insecticide treatment in FY86.

This paper documents the procedure which was used to model the economic feasibility of a project or series of projects designed to control the current western spruce budworm epidemic on the Deschutes National Forest. The current epidemic was first identified and mapped during the summer of 1984 by the Cooperative Forest Insect Aerial Detection Survey, conducted by the Forest Pest Management group in the Regional Office. At the present time the outbreak is confined to approximately 20,000 acres on the Sisters and Bend Districts. Outbreaks have also been mapped on the Warm Springs Indian Reservation and the east slopes of the Mt. Hood National Forest. Forest Pest Management entomologists have predicted that the western spruce budworm will have a 7- 10 year outbreak cycle in Eastern Oregon and will infest the whole host type during the outbreak.These outbreak predictions for Eastern Oregon have proven true in most cases. Outbreaks on the Deschutes have historically been less extensive and of shorter duration than those in Eastern Oregon.

To determine the potential extent of a western spruce budworm epidemic on the Deschutes National Forest, it was first necessary to define and identify stand conditions which could serve as host to the budworm. During the current analysis of project feasibility on the Mount Hood National Forest and on lands managed by the State of Oregon, host acres have been defined as those with greater that 30 percent host species (Douglas-fir, grand fir, and white fir) in the crop tree component of the stand. In addition, host stands occurred below the 90 inch precipitation zone. Following a discussion and concurrence by Bruce Hostetler, Regional Office entomologist, I made the assumption that this

definition of host stands would also apply to the Deschutes.

Following identification of the host type, it was necessary to determine the total number of acres on which the host type occurred. Rather than pursue an independent mapping process, I used the existing 1972 timber inventory and 1978 stand mapping to determine acres of host type. Based on this timber inventory, the mature mixed conifer working group consists of 40 percent host species, as measured in board feet. The immature mixed conifer working group consists of 41 percent host species. Both working groups fall below the 90 inch precipitation zone. At this point I made the assumption that host acres on the Deschutes, for the pupose of this analysis, consisted of all acres of mixed conifer working group which were not included in sold timber sales as of October 1, 1983. Having made this assumption, the 1978 stand mapping provided an automated mapping solution to the question. Additional acres of host type within designated wilderness areas were also recorded. Table 1 presents the results of this host acre analysis. Within the commercial forest zone on the Deschutes, approximately 172,000 acres or 11 percent of the commercial forest acreage consists of western spruce budworm host type. A more refined and site specific process would be necessary to determine treatment acres for an actual project. Because host acres were defined using the mixed conifer working group, further analysis could be developed using the FORPLAN model, which also recognizes this working group as a mapping unit in the forest planning process. Timber values, value increase assumptions and costs associated with timber management have also been developed for this working group in the forest planning process. These values, assumptions and costs were also used in this analysis.

One central question remained unanswered at this point: what is the impact of a western spruce budworm epidemic on timber volumes produced and the subsequent value of that timber? Other Forests in the Region experiencing the budworm epidemic have used the PROGNOSIS stand growth simulation model and a subroutine which simulates the impacts of a budworm outbreak on stand growth and development. At the present time this model is not calibrated for the Deschutes National Forest. After discussion and concensus by a group of interdisciplinary team members at a budworm meeting on October 15, 1984, I used data supplied by the Wenatchee National Forest to simulate impacts on timber volume growth on the Deschutes. The Wenatchee used PROGNOSIS and the western spruce budworm subroutine to model these impacts. Empirical stand volume growth was modeled: 1.) without the effect of a budworm epidemic, 2.) with the effect of an untreated budworm epidemic, 3.) with the effect of a budworm epidemic treated in the third year of its development. This analysis was developed for each Wenatchee working group and management strategy. A simple calculation yielded the reduction in empirical volume growth based on the strategies of both no treatment and treatment-year-three.

At this point a complicated and approximate process was used to assign yield reductions from the Wenatchee to the Deschutes. The Wenatchee empirical yield tables for mixed conifer host type are stratified into a wet type (mean site index 83) and a dry type (mean site index 70). For the Deschutes, empirical yields for mature stands are stratified into a Sisters and Crescent District type (mean site index 80) and a Bend and Fort Rock type (mean site index 60). For the purposes of this analysis, I assigned the yield reductions for the Wenatchee wet type to Sisters and Crescent empirical yields. I assigned the yield reductions for the Wenatchee dry type to the Bend and Fort Rock empirical

TABLE 1

Deschutes National Forest

Western Spruce Budworm Host Acre Analysis 1/2/

land class	condition class	Ranger District D1	D2	D3	D5	total
commercial forest	seed/sapling	2.2	1.4	2.0	2.0	7.6
	immature saw	3.0	0.6	1.2	5.1	9.9
	mature saw	49.5	38.8	9.3	56.5	154.1
	total (M ac.)	54.7	40.8	12.5	63.6	171.6
wilderness	seed/sapling					0.3
	mature saw					57.3
	total (M ac.)					57.6
grand total host acres (M ac.)						229.2

1/ In this analysis, host acres are considered to be all acres of mixed conifer working group, not included in sold sales as of October 1, 1983. Based on the 1978 Timber Inventory update, host component (Douglas-fir and all true fir) within mixed conifer working group is 40 percent in mature and 41 percent in immature condition classes.

2/ All acres are displayed as M acres.

yields. The fit here appeared logical. Deschutes empirical yields for immature stands use one yield table which represents all Districts. Here, I weighted the reductions for the Wenatchee wet and dry types based on the total acres of immature mixed conifer on the Sisters and Crescent Districts (wet), and on the Bend and Fort Rock (dry). For the mature mixed conifer working group, yield reductions ranged from 2- 10 percent for no treatment and from 1-3 percent for treat-year-three, depending on management strategy. Yield reductions for immature mixed conifer ranged from 0- 24 percent for no treatment and 0- 12 percent for treat-year-three, again depending on management strategy.

The wet and dry host components on the Wenatchee were further defined as mature, two-story, and immature. The management strategy for mature stands was final harvest (clearcut). The strategies for two-story stands included final harvest or overstory removal followed by commercial thinning. The strategies for immature stands included final harvest or a series of two commercial thinnings followed by a final harvest. The Deschutes recognizes only mature and immature host components. Within the mature component, the 1978 Deschutes FORPLAN current direction run, schedule of harvested acres includes 80 percent final harvest and 20 percent overstory removal prescriptions for the Bend and Fort Rock Districts (dry type). The same FORPLAN run schedules 87 percent final harvest and 13 percent overstory removal prescriptions for the Sisters and Crescent Districts (wet type). I assigned the empirical volume growth reductions for the Wenatchee mature and two-story host components to the Deschutes mature component weighted by the harvest acres scheduled for either final harvest or overstory removal prescriptions. Growth reductions for the Wenatchee immature component were more difficult to assign to the Deschutes. Growth reductions for the immature final harvest strategy were assigned directly, using the procudure outlined above. Growth reductions for commercial thinning and final harvest were assigned as could best be fit from Wenatchee projections. The immature component composes only 6 percent of the total host type in the commercial forest zone, so any lack of accuracy here has a relatively small effect on the outcome. It is important to keep in mind that the Wenatchee PROGNOSIS analysis assumes no reduction in volumes of timber which are harvested during the first decade.

The adjusted harvest volumes which reflect an untreated western spruce budworm epidemic and an epidemic treated in year three were appropriately recoded into the FORPLAN model. Six lines of data were recoded for each alternative. At that point the 1984 FORPLAN current direction run was rerun to reflect the impacts of a treated and untreated epidemic. Bill Anthony, Deschutes forest analyst and I discussed parameters which are important to consider when analyzing a project of this nature. The economic feasibility can best be measured for each alternative using the present net value (PNV) of the Deschutes National Forest. This analysis uses a 4 percent discount rate. The impact on timber outputs of each alternative can best be measured using the long run sustained yield and the allowable harvest quantity for the first 5 decades. This data is presented in Table 2.

Treatment alternatives typically include carbaryl insecticide and Bacillus thuringiensis (BT), a bacterium used as a biological insecticide. On National Forests where budworm has been treated recently, BT has been applied along streamsides and in other sensitive areas. Treatment costs for the treat-year-3 alternative were developed outside the FORPLAN analysis and subtracted from the

TABLE 2

Deschutes National Forest
Western Spruce Budworm Control Project Feasibility Analysis 1/
Worst Case Scenario 4/

Comparative Element	Strategy Alternatives: No Budworm	Budworm Treat Year 3	Budworm Untreated
Present Net Value (MM$)	751.627	746.678 3/ 745.297 6/	744.865 3/
Long Run Sustained Yield (MMCF/Decade)	416.057	415.036 2/	412.968 2/
Allowable Harvest (MMCF/Decade)			
Decade 1	396.100 5/	396.100 5/	396.100 5/
Decades 2-5	416.057	415.036	412.968

1/ This analysis is made using the FORPLAN model, current direction run for the Deschutes National Forest as a basis for analysis. Spruce budworm impacts on empirical stand development were adapted from Wenatchee National Forest data developed using the PROGNOSIS model.

2/ Reductions in the long run sustained yield from the no budworm strategy can be at least partially explained by the FORPLAN model's preference to harvest ponderosa pine rather than host acres of mixed conifer during decades 2-15 when faced with a reduced harvest volumes associated with a spruce budworm outbreak. These acres of unprogrammed mixed conifer occur primarily in the foreground retention and partial retention zones where costs associated with timber management are greater. This analysis suggests that the long run stained yield can be increased by 2,068,000 cubic feet/ decade if a spruce budworm outbreak is successfully treated in year 3 rather than left untreated.

3/ This is the PNV of the Deschutes National Forest, assuming a 4% discount rate. The PNV for the budworm treatment-year-3 strategy includes a cost of $8.95/acre to treat all 229,200 host acres on the Deschutes National Forest with one application of insecticide. This analysis suggests that the present net value of the Forest can be increased by $1,813,000. if a spruce budworm outbreak is treated in year 3 rather than left untreated. The FORPLAN model considers only values related to timber outputs.

4/ This analysis assumes that all host acres within the commercial forest zone will experience spruce budworm defoliation.

5/ The decade 1 allowable harvest remains constant regardless of strategy. PROGNOSIS model data assumes no impact to timber volumes harvested during the first decade regardless of spruce budworm defoliation.

6/ The PNV here includes a treatment cost of $20.00/acre for multiple treatments on 171,600 acres of commercial forest land, excluding wilderness areas. In this case, the treat-year-3 strategy increases the PNV by $432,000 when compared to the untreated strategy.

PNV. Treatment costs were developed for two separate treatment strategies: 1.) all 229,200 host acres on the Deschutes, including host acres in wilderness, would be treated one time at a cost of $8.95 per acre or $2,051,340 for the project, 2.) only 171,600 host acres of commercial forest land would be treated, requiring up to 3 applications at a cost of $20.00 per acre or $3,432,000 for the project. Multiple treatments would be required because host acres of wilderness are left untreated and budworm reinfestation into the commercial forest zone is predicted. This would also be the case where areas adjacent to recreational developments or subdivisions remain unsprayed. These costs and assumptions are consistent with those used on other National Forests assessing treatment feasibility.

It is also important to remember that this analysis assumes all host acres will become defoliated and after the first decade all harvest volumes will be reduced by the factor developed through PROGNOSIS simulation. This assumption was made because the FORPLAN model cannot assign volume reductions indiscriminately to selected acres and not to others. Because of this restriction, FORPLAN presents a worst-case scenerio of the impacts of western spruce budworm on the forest. In reality all host acres would probably not be defoliated and the impacts to PNV, long run sustained yield and the allowable harvest quantity would be less significant than that predicted.

This analysis is unique from those of other National Forests in that yield reductions caused by budworm are coded into the empirical yield tables and the FORPLAN model is allowed to find the optimum solution when constrained by an outbreak. Here it can substitute working groups or management strategies to determine that optimun solution which maximizes present net value. Other National Forests use FORPLAN run outputs for current direction unconstrained by budworm and outside the model adjust yields to reflect the impact of the epidemic.

Based on this analysis, the PNV of the timber resource on the Deschutes National Forest would increase by $1,813,000 (2/10 of 1 percent) if a western spruce budworn epidemic is treated with one application of insecticide on all host acres. The PNV would increase by $432,000 (6/100 of 1 percent) if an epidemic is treated with multiple applications of insecticide on host acres in the commercial forest zone. The long run sustained yield on the Deschutes would increase by 2,068,000 cubic feet per decade (5/10 of 1 percent) if the epidemic is successfully treated on all host acres. This equates to an increase in productivity of 1.2 cubic feet per acre per year or roughly 100-140 cubic feet per acre per rotation in the mixed conifer working group (a 1 percent increase in yield for this working group). The allowable harvest quantity for the first decade remains unchanged because the PROGNOSIS model assumes no reduction in volume harvested during this period. The allowable harvest quantity during the second through fifth decades rises to the long run sustained yield level.

Reductions in the long run sustained yield from the no budworm FOPRPLAN current direction run can be at least partially explained by the model's preference to harvest ponderosa pine rather than host acres of mixed conifer during decades 2- 15. The reduced harvest volumes associated with a spruce budworm epidemic on acres which were previouly only marginally economical cause the model to move these acres into an unprogrammed and uneconomical to harvest category. These acres occur primarily in the foreground retention and partial retention

zones where both the constraints on volumes harvested and the costs associated with timber management are greater. In its place, the model harvests additional acres of ponderosa pine.

The Western Spruce Budworm Analysis Core Team consulted with specialists from other resource areas to answer the question: is budworm-caused defoliation affecting other resource values such as fisheries and wildlife habitat, water quality and quantity, and aesthetics, or is it adding to fuel loading or otherwise increasing fire hazard? In all cases, budworm activity is predicted to cause only a slight, temporary or unmeasurable effect on other resources.

In summary, this analysis suggests that in a worst-case epidemic scenerio, the PNV of the timber resource on the Deschutes National Forest would increase by less than 1/2 of 1 percent if the outbreak is successfully treated with insecticides. This equates to a positive change in PNV of $432,000 for a multiple treatment of commercial forest lands and $1,813,000 for a single treatment to all host acres. The long run sustained yield would increase by 1/2 of 1 percent or 2,068,000 cubic feet per decade if the outbreak is successfully treated. This is roughly equivalent to a gain in volume of one large timber sale per decade. Impacts to other resource areas from an untreated outbreak appear minimal. Because the current forest planning effort assumes no spruce budworm defoliation and no associated volume reductions, there is also a need to monitor the impacts of this epidemic and modify projected empirical yields if necessary.